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Winter Wave Power Variability Along the U.S. Atlantic and Pacific Coasts

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Abstract: Under rising sea levels, more wave energy will reach farther shoreward, accelerating coastal erosion and associated shoreline change. Extremes in wave power at the shore will have increasingly severe societal impacts. Changes in winter wave power extremes are directly related to changes in the character and track of extratropical cyclones. A tropical cyclone (TC) wave power index (WPI) for the western North Atlantic shows a significant increase along the U.S. Atlantic coast since the mid-1990‘s, both at open-ocean and at near-coastal locations. The TC WPI is well correlated with the observed increase in the Atlantic power dissipation index (PDI), and appears to be modulated by the Atlantic Meridional Mode (AMM). This association of the TC WPI to large-scale atmospheric variability suggests that winter WPI may also associated with broad-scale climate patterns. The WPI is a useful metric for assessing interannual and decadal wave power variability and trends, and may be an indicator of coastal erosion potential.

We propose to determine an Atlantic winter WPI using the network of NOAA buoys in the western North Atlantic, and characterize the extreme-event, monthly, and seasonal wave power variability to understand whether, and to what extent, the character of wave power extremes are changing. The buoy analysis will be extended both spatially and temporally with a parallel analysis of WAVEWATCH III wave model data. We will investigate the association of wave power extremes and winter WPI variability with the Pacific-North America (PNA) atmospheric pattern and other broad-scale North Atlantic climate modes of variability, e.g. NAO. We will also estimate the joint probability of extreme waves and extreme sea levels, both for hindcast waves and NOAA tide gauge observations and for predicted tides and sea level rise projections under high and low greenhouse gas emission scenarios.

The U.S. Pacific coast is also subject to strong winter waves, and has the benefit of much longer near-coastal buoy time series than the Atlantic coast. We will develop both open ocean and near-coastal winter WPI for the eastern North Pacific using available NOAA buoy data and parallel WAVEWATCH III data, analogous to that determined for the Atlantic coast. Associations with Pacific modes of climate variability (e.g. ENSO, PDO, PNA) and the Atlantic winter WPI will also be investigated. Patterns of wave power extremes, variability, and their coastal expression will be determined, as well as the joint probability of extreme waves and extreme sea levels.